MODULE CONTENT

| Unit of Competency | **DIAGNOSE AND REPAIR BODY ELECTRICAL SYSTEM** |
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| Module Title | **DIAGNOSING AND REPAIRING BODY ELECTRICAL SYSTEM** |
| Module Descriptor | This unit covers the knowledge, skills and attitudes  required to diagnose and repair body electrical system  such as lighting, wiper, door locks, power window, horn,  accessories and other electrical system |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair body electrical system | |
| LO2. Diagnose body electrical system | |
| LO3. Repair body electrical system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 1**

**PREPARE TO DIAGNOSE AND REPAIR BODY ELECTRICAL SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Prepare to diagnose and repair body electrical system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Prepare to diagnose and repair body electrical system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Prepare to diagnose and repair body electrical system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Prepare to diagnose and repair body electrical system | Remember the step-by-step procedure of the Prepare to diagnose and repair body electrical system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**PREPARE TO DIAGNOSE AND REPAIR BODY ELECTRICAL SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Inspection and Replacement of bulbs, fuses, relays and

switches

1. Inspection and Repair wiring harness and connectors
2. Inspection and Replacement of power regulator, motor,

power door lock, wiper and washer motor, horn, air conditioner and electrical accessories

**BODY ELECTRICAL SYSTEM**

The lighting system provides power to both exterior and interior lights. It consist of the headlights, parking lights, marker lights, taillights, courtesy lights, dome/map lights, instrument illuminator or dash lights, coach lights (if so equipped), headlight switch, and various other control switches (Figure 20 – 1). Other lights, such as vanity mirror lights, the underhood light, are used on some vehicles and are also part of the lighting system.



**Figure 20-1** Automotive lighting systems.

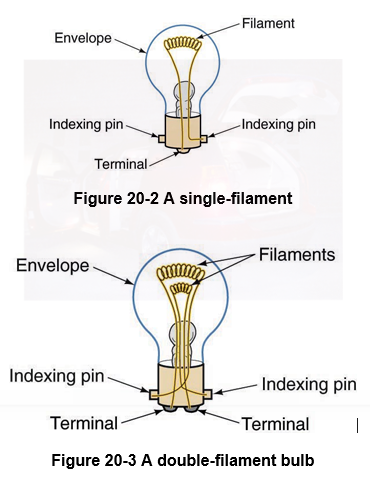
Other lights that are not usually in the main lighting system are turn signal, hazard warning, backup, and stop retractable headlight covers found on some vehicles, are operated by separate control circuits and are covered later in this chapter.

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|  |  | | **SHOP TALK**  Lighting systems are largely regulated by federal laws, so the systems are similar among the various manufacturers. However, there are many variations. Before attempting to do any repairs on an unfamiliar systems, you should always refer to the manufacturer‘s service manual | | --- | |  |
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**LAMPS**

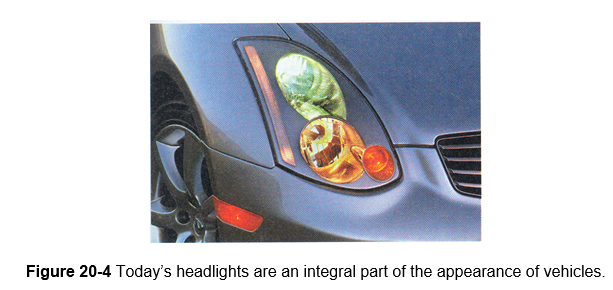
A **lamp** generates light as current flows through the filament. This causes it to get very hot. The changing of electrical energy to heat energy in the resistive wire filament is so intense that the filament starts to glow and emits light. The glass enveloped that encloses the filament is evacuated so that the filament “burns” in a vacuum. If air enters the envelope, the oxygen would cause the filament to oxidize and burn up.

It is important that any burned-out lamp be replaced with the correct lamp. You can determine what lamp’s standard trade number, usually present on the lamp’s housing. Lamps are normally one of two types: a single filament **(Figure 20 – 2)** or a double filament **(Figure 20 -3).** Double-filament bulbs are designed to serve more than one function. They can be used as the lone bulb in the stop light circuit, taillight circuit, and the turn signal circuit.



**HEADLIGHTS**

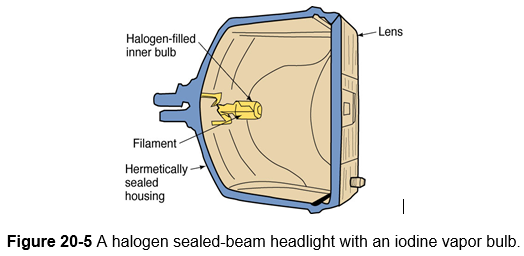
Headlights light the road ahead during darkness or at other times when normal visibility is poor. Headlight designs and construction have been influenced by the changes in technology. In the past, all cars had two or four round headlights. Now headlights are an integral part of a vehicle's overall design **(Figure 20-4)**. The headlights of today’s vehicles are based on sealed-beam, composite, or high intensity discharge lamps.



**Sealed-Beam Headlights**

The standard **sealed-beam** headlight is an air-tight assembly with a filament, reflector, and lens fused together. The parabolic reflector is sprayed with vaporized aluminum and the inside of the lamp is typically filled with argon gas. The reflector intensifies the light produced by the filament, and the lens directs the light to form the required beam pattern. The lens is designed to produce a broad flat beam. The light from the reflector is passed through concave prism in the glass lens.

Today, the most commonly used sealed-beam-light is the halogen type. A **halogen** lamp typically consists of a small bulb filled with iodine vapor. The bulb is made of high-temperature-resistant glass and it surrounds a tungsten filament. The halogen-filled inner bulb is then installed in a sealed glass or plastic housing **(Figure 20-5).** With the halogen added to the inner bulb, the tungsten filament is capable of withstanding higher temperature than that of standard sealed-beam lamps. Because it can withstand higher temperatures, it can burn brighter.

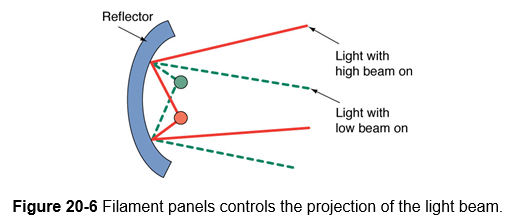


Halogen is the term used to identify a group of chemically related nonmetallic elements. These elements include chlorine, fluorine, and iodine.

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| | **SHOP TALK**  Because the filament is contained in the inner bulb, cracking or breaking of the housing or lens does not prevent a halogen bulb from working. As long as the filament envelope has not been broken, the filament will continue to operate. However, a broken lens results in poor quality and the lamp assembly should be replaced. | | --- | |
| --- | --- |

Low-and-high-beam filaments are placed at slightly different location, relative to the reflector, determines how light passes through the bulb’s lens **(Figure 20-6),** which in turn, determines the direction in which the light shines. In a dual filament lamp, the lower filament is used for the high beam and the upper filament is used for the low beam.



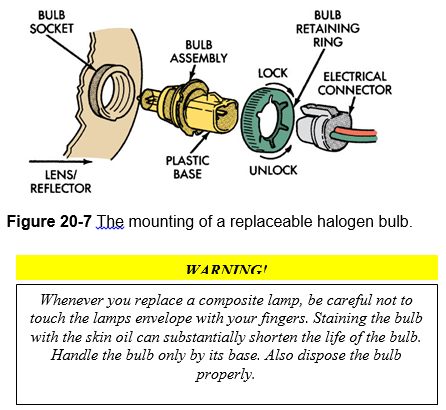
Various methods are used to identify sealed-beam headlights, such as 1, 2 and the “halogen” or “H” marking molded on the front of the headlight lens. A type 1 has high beam only and has two electrical terminals on its back. The type 2 has both low and high beam and three terminals. When the type 2 is switched to low beam, only one of its filaments is lit. When high beam is selected, the second filament lights in addition to the low beam.

If a sealed-beam headlamp has condensation on the lens or inside the assembly or if it is cracked, the headlamp will not work and can only be repaired by replacing it.

**Composite Headlights**

Many of today’s vehicles have halogen headlight systems that use a replaceable bulb **(Figure 20-7).** These systems are called composite headlights. By using the composite headlight system, the manufacturers are able to produce any style of headlight lens they desired. **(Figure 20-8),** which improves the aerodynamics, fuel economy, and styling id the vehicle.

Many manufacturers vent the composite headlight housing due to the intense heat developed by these bulbs. Because the housing are vented, the condensation may developed inside the lens assembly. This condensation is not harmful to the bulb and does not affect headlight operation. When the headlights are turned on, the heat generated by the halogen bulb dissipates the condensation quickly. Ford uses integrated novented composite headlights. On these vehicles, condensation is not considered normal. The assembly should be replaced.



**HID Headlamps**

High-intensity discharge (HID) or xenon headlamps use gas-discharge lamps and are electronically controlled. These lights are recognizable by the blue-white color of their light **(Figure 20-9).** They have this color because the light spectrum is much closer to daylight than that of the halogen bulb.



Instead of using a filament, an electrical arc is created between two electrodes that excite a gas (usually xenon) inside the headlamp **(Figure 20-10),** which in turn vaporizes metallic salts that sustain the arc and emit light. The presence of an inert gas amplifies the light given off by this arcing.

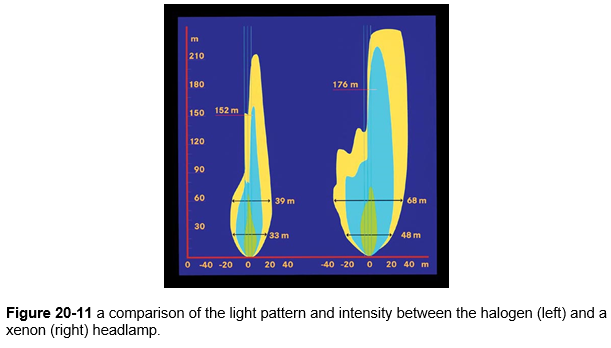


More than 15,000 volts are used to jump the gap between the electrodes. To provide this voltage, a voltage booster and controller is required. Once the high voltage bridges the gap, only about 80 volts are needed to keep current flowing across the gap. When the headlights are switched on, it takes approximately 15 seconds for the lamp to reach maximum intensity. However, even during ignition these lamps provide more than adequate light for sale driving.

Xeon headlights illuminate the area to the front and side of the vehicle with a beam that is both brighter and much more consistent than that the light generated by the headlamps. The great light output of these lamps allows the headlamp assembly to be smaller and lighter. Xenon lights also produce significantly less heat.

Xenon headlights produce about twice as much light as comparable halogen headlights **(Figure 20-11)** and make night driving safer and less tiring for the driver’s eyes. Xenon headlamps also use about two-thirds less power to operate and will last two or three times as long.

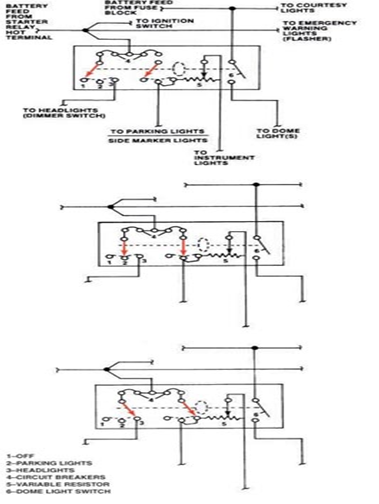
**Bi-Xenon Lights** some vehicles have bi-xenon headlamps that provide xenon light for how low and high beams. These may also be fitted with halogen lights that are used for the flash-too-pass feature. Bi-Xenon lights rely on a mechanical shield plate, or shutter, that physically obstructs a portion of the overall light beam emitted by the arc. When the driver selects the high beams, the shutter reacts and allows the headlights to project the complete, unobstructed light beam.



**Headlight Switches** Headlight switches are either mounted on the dash panel or are part of a multifunction switch on the steering column. The headlight switch controls most of the vehicle’s lighting systems. The most common style of headlight has three positions: OFF, PARK, and HEADLIGHT. A headlight switch normally allows the light circuits to be operated without having the ignition switch in the RUN or ACC (accessory) position.

When the headlight switch is in the OFF position, the open contacts prevent battery voltage from continuing in the lamps **(Figure 20-12A).**  When the switch is in the PARK position, battery voltage is applied to the parking instrument panel lamps **(Figure 20-12B).** This circuit is usually protected by the headlight circuit.

When the switch is in the HEADLIGHT position, battery voltage is applied to the headlights. The lamps lit by the PARK position remain on **(Figure 20-12C).** Normally, a self-resetting circuit breaker is installed between the battery feed and the headlights. The circuit breaker is designed to reset itself. If a problem causes the breaker to open, the lights will go off until the breaker resets. Then the lights will come back on. If there is a serious problem in the circuit, the headlights might flash as the breaker cycles. Some vehicles have a separate fuse for the headlight on each side of the vehicle. This allows one headlight to operate if there is a problem in the circuit for one side of the vehicle.



**Figure 20-12** A headlight switch (A) in the OFF position; (B) in the PARK position; (C) in the ON position.

The instrument pane; lights come on whenever the headlight switch in the PARK or HEADLIGHT position. The brightness of these lamps is adjustable. A rheostat is used to allow the driver to control may be part of the headlight switch, in which the case the driver simply rotates the headlight switch knob to adjust the panel light. Not all headlight switches are designed to control the instruments panel lights. Many vehicles have a separate unit on the dash to control the panel lights **(Figure 20-13).**



Headlight switches are basically one of the three designs. A common switch setup is the rotary switch. Turning the knob of the switch to the PARK or HEADLIGHT position energizes the appropriate lights. The switch’s knob also serves as the dimmer control for the instrument panel lights. Some vehicles also a push-button switch. The driver merely pushes a button for the desired set of lights. When this type switch is used, there is a separate instrument panel light control. There is also a separate panel light control panel when vehicles are equipped with a steering-column-mounted headlight switch **(Figure 20-14).**  To select the desired lighting mode, the driver turns the knob at the end of the switch.

**Dimmer Switches**

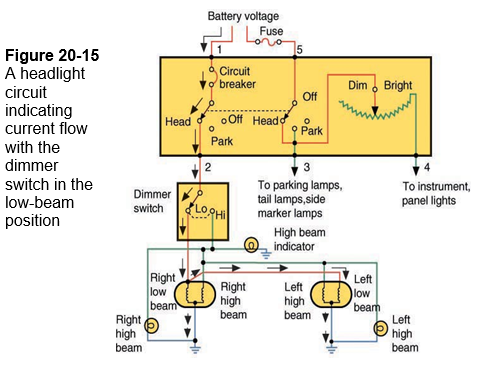
The **dimmer switch** provides a way for a way for the driver to switch between high and low beams. A dimmer switch is connected in series with the headlight circuit and controls the current path to the headlights. The low-beam headlights are wired separately from the high-beam lamps.

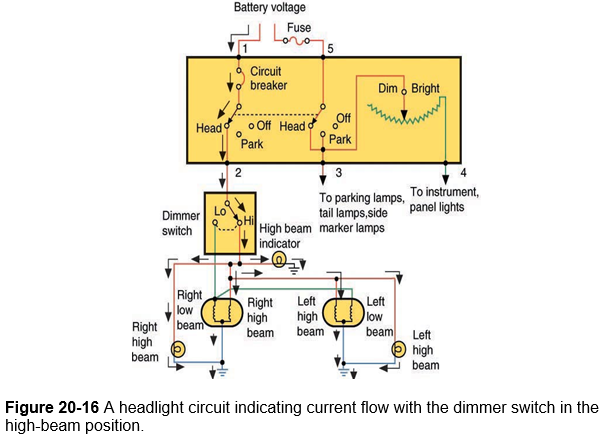
Man years ago the dimmer switch was located on the floor. To switch between low and high beams, the driver used his or her foot to press the switch. This type switch worked, but it was subject to damage because of rust and dirt. Newer vehicles have the dimmer switch on the steering column. This prevents early switch failure and increases driver’s accessibility.



**Headlight Circuits**

The composite headlight circuit consists of the headlight switch, dimmer switch, high-beam indicator, and the headlights. When the headlight switch in the HEADLIGHT position, current flows to the dimmer switch **(Figure 20-15).** If the dimmer switch is in the low position, current flows through the low-beam filament of the headlights. When the dimmer switch is in the HIGH position, current flows to the high beam headlights **(Figure 20-16).**





The headlight circuits just discussed are designed with switches that control battery voltage and the bulbs have a fixed ground. In this system, battery voltage is present at the headlight switch. The switch must be closed to have voltage present at the headlights. Many manufacturers use a system that relies on a groundside switch to control the headlights. In these systems, voltage is always available at the headlights. A closed headlight completes the circuits to ground and the headlights turn on. In this system, the dimmer switch is also a ground control switch.

**Daytime Running Lights**

Canadian law requires that all new vehicles be equipped with **daytime running lights (DRL)** for added safety. This feature is also standard equipment on all new GM vehicles sold in North America. The system normally uses the vehicle’s high-beam lights. The control circuit is connected directly to the vehicles’s ignition switch so the lights are turned on whenever the vehicle id running. The circuit is equipped with a module that reduces 12-volt battery voltage to approximately 6 volts. This voltage reduction allows the high beams to burn with the less intensity and prolongs the life of the bulbs. When the headlight switch is moved to the HEADLIGHT position, the module is deactivated and the lights work their normal intensity and brightness. Applying the parking brake also deactivates the DRL system so the lights are not on when the vehicle is parked and the engine is running.

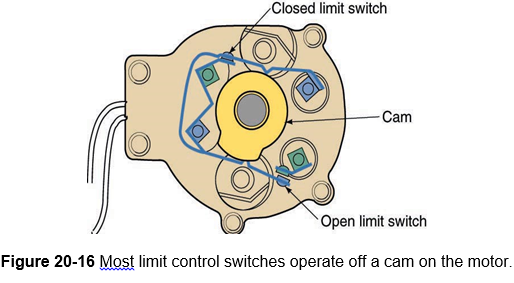
**Concealed Highlights**

Although not as common as they were a few years ago, concealed highlights are still found on some cars. Manufacturers use a concealed headlight system to improve the vehicle’s aerodynamics. Today, low profile headlight assemblies are being used instead of concealed headlights. However there are cars out there with pop-up headlights.

When the headlight switch is moved to the HEADLIGHT position, the entire headlamp bulb and adjuster assembly pivots upward. These headlights are controlled by electric or vacuum motors.

Vacuum systems have headlight switch and vacuum motors attached to the headlight assembly. With the headlight switch OFF position, engine vacuum is applied to the motors to keep the headlight doors closed. When the headlight switch is moved to the HEADLIGHT position, the vacuum distribution valve vents the vacuum that is held in the vacuum motors, which allows springs at the doors. These systems are also equipped with a bypass valve that allows the doors to manually open in case the system fails.

Typically, electrically controlled systems use a torsion bar a single motor to open both doors or have a separate motor for each headlight door. When the headlight switch is moved to the HEADLIGHT position, current id sent to the motors. This current turns on the motors and causes the doors to open or close. Limit switches stop current flow to the motors when they are completely open or closed **(figure 20-17).** Electrically operated headlight doors also have a provision for manually opening the doors in case a system failure.



**Flash to Pass**

Most steering-column-mounted dimmer switches have an additional feature called **flash to pass.** This circuit illuminates the high-beam headlights even with the headlight switch in the OFF or PARK position. When the driver activates the flash to pass feature, the contacts of the dimmer switch complete the circuit to the high-beam filaments.

**Automatic Light Systems**

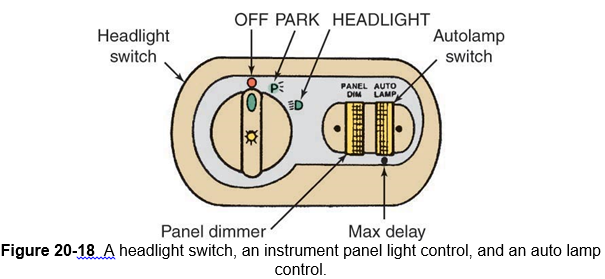
These provide light-sensitive, automatic on-off control of the light controlled by the regular headlight switch. It consists of a light-sensitive **photocell sensor/amplifier** assembly and a headlight control relay. Turning the regular headlight switch on overrides the automatic system. In other words, automatic operation is not possible until the regular headlight switch is turned off.

In normal operation, the photocell sensor/amplifier, which is usually mounted under a group of perforated holes in the upper instrument panel pad or slotted holes in the defroster grill panel, is exposed to ambient light. As the light level decreases, the light sensor’s resistance increases. When the resistance increases to the present amount, the amplifier applies power to the headlight relay coil. The headlight, exterior light, instrument illumination lights turn on. The light remains on until the system is turned off or the system is turned off or the ambient light level increases.

Some systems have two sensors to monitor the ambient light. The light sensors monitor the intensity of the ambient light at an extended angle above the vehicle an in a narrow angle tp the front of the vehicle.

An automatic headlight dimmer system is also available on some vehicles. These systems automatically switch form the high beams to low beams when the intensity of light as its photocell increases. The source of light could be the environment, the headlight of an approaching vehicle, or the taillights of a vehicle. Typically the driver is able to set the sensitivity of the photocell to meet the current driving conditions.

Most automatic light systems have a headlamp delay system as well. This system allows the headlamps to stay the ignition switch is turned off. A variable switch **(Figure 20-18)** allows the driver to set the amount of time the headlights should remain on after the ignition id turned off. The system can typically be adjusted to keep the headlights on for up to three minutes after the ignition is turns off. Of course, the driver can turn off the delay system and the headlamps will shut off as soon as the ignition if turned off.

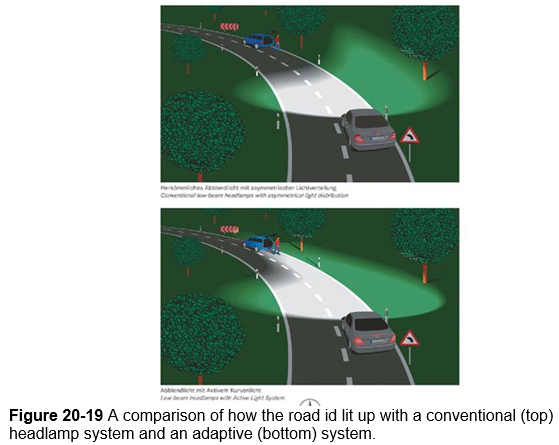


***CUSTOMER CARE***

*If the customer’s car is equipped with an automatic light control system, point out the location of the perforated holes or slots. Warn the customer not to place any items that may block light from the sensor/amplifier assembly. Blockage causes erratic operation of the system. The photocell must be always be exposed to an outside light to function properly.*

***Adaptive Headlights***

*Adaptive headlights systems swivel the base of the head-lamps to illuminate any curve in the road* ***(Figure 20-19).*** *The system responds to signal from a steering wheel angle sensor and swivels the headlamps with smell bidirectional motors* ***(Figure 20-20).*** *Adaptive headlights are able to rotate up to 15 degrees to the right or to the left. The headlight on the side of the vehicle that is opposite of the direction of the turn swivels about half a distance as the headlamp leading into the curve. The system responds in real time by responding to the car’s current steering angle, its yaw rate, and road speed.*

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Adaptive headlights can be additionally controlled by global positioning system (GPS) satellites navigation and digital road maps. Plotting the road ahead supplies the information needed by the control unit to anticipate road curves and to enable the adaptive headlamps to illuminate curves with optimum brightness and light intensity even before the driver starts to run the steering wheel.

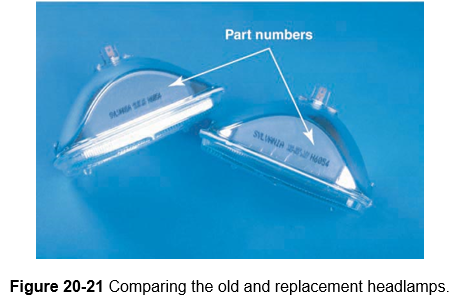
**HEADLIGHT SERVICE**

When there is a headlight failure, it is typically caused by a burned-out bulb or lamp, especially if only one lamp fails. However, it is possible that the circuit for that one lamp has an open or high resistance, check for the voltage present, the circuit needs work and the original bulb may still be good. If more than one lamp (including the rear lights) is not working, carefully check the circuit. A problem is there much more likely than having a number of burned-out bulbs. Of course, if the charging system is not being regulated properly, the high charging system id not being regulated properly, the high voltage will cause lamps to burn out prematurely.

**Headlight Replacement**

There can be slight variations in procedure from one model to another when replacing headlights. For instance, on some models the run signal light assembly must be removed before the headlight can be replaced. Overall, the procedure does not differ much from the following typical instructions.

Make sure the replacement bulb is the same type and part number as the one being replaced. **(Figure 20-21).**

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**SHOP TALK**

***Because of the extreme high voltages involved, any work on xenon lighting should be done carefully and according to the manufacturer’s recommendations***